FIELD TECHNIQUES IN A STUDY OF THE BEHAVIOR OF PEREGRINE FALCONS*

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ABSTRACT: This discussion outlines techniques and philosophies used in a behavioral study of resident coastal Peale's Peregrines on the Queen Charlotte Islands, British Columbia. The principal aim of the study was to produce a qualitative and quantitative description of Peregrine breeding behavior (February through September). Such information will be applicable to problems in falcon management, biocide contamination, and captive breeding. Naturalistic observations formed the basis of the study, i.e. no experimentation or manipulation was undertaken.

Methods included observing from a distance and from blinds. With caution, over a period of time, it is usually possible to habituate falcons to accept an observer in full view within 100 to 200 m of the nest cliff. At this distance fruitful observations are possible. Habituated falcons appear to treat the observer much like a deer, sealion, or other animal. Satisfactory blinds can be constructed of canvas and PVC, natural and beachcombed poles, wire, and staples, with camera and telescope slits, and one-way glass windows. Disturbance to the falcons has been minimal with these methods.

Data recording was largely in detailed diary form, although this method is time-consuming in the analysis phase. In the field, however, when combined with tape recorded dictation of very rapid sequences, diary notes are satisfactory. 35 mm still and 16 mm movie cameras also provide useful information by preserving fleeting behavior postures and by allowing subsequent frame-by-frame analysis. Similarly, tape recordings of calls yield useful information.

Some special equipment, techniques, and problems are described, and some results illustrated.

Introduction

Knowledge of a particular species' behavior is useful, particularly to those investigating population dynamics, ecology, movements, transplantations and reintroductions, rehabilitation, and captive breeding of birds. Most avian behavior papers deal primarily with results and describe methods only briefly. This paper: (1) outlines a recent field behavior study of Peale's Peregrine Falcons (*Falco*

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peregrinus pealei), (2) describes techniques used, (3) discusses problems encountered and their solutions, and (4) shows some preliminary results of the study.

The behavior of raptors is still poorly explored. Substantive behavior studies have been conducted on the following species and others: Burrowing Owl (*Speotyto cunnicularia*) (Coulombe 1971, Thomsen 1971); Northern Goshawk (*Accipiter gentilis*) (Schnell 1958); Rough-legged Hawk (*Buteo lagopus*) (Schnell 1967, 1969); Red-tailed Hawk (*Buteo jamaicensis*) (Fitch *et al.* 1946, Grier 1971); Marsh Hawk (*Circus cyaneus*) (Hamerstrom 1969); American Kestrel (*Falco sparverius*) (Cade 1955, Willoughby and Cade 1964, Olendorff 1968, Mueller 1971); European Kestrel (*Falco tinnunculus*) (Tinbergen 1940); Hobby (*Falco subbuteo*) (Schuyl *et al.* 1936, Tinbergen 1958); Peregrine (Herbert and Herbert 1965, Nelson 1970, 1971, Fyfe 1972, Enderson *et al.* 1972), and Prairie Falcon (*Falco mexicanus*) (Fyfe 1972).

While on the study area on the Queen Charlotte Islands, British Columbia, I sought to obtain an over-all understanding of all breeding season activities of Peale's Peregrines without concentrating on any particular aspect. I have been in the field from early courtship (February) to when the last youngsters become independent of their parents (September). An M.Sc. thesis (Nelson 1970) deals with the qualitative aspects of Peregrine behavior (what the behavior patterns are); I am presently analyzing Peregrine behavior quantitatively (when, where, how often, how many).

Climate, Terrain, Travel, and Comfort

Severe limitations are placed upon equipment and observation methods by the weather and terrain. Over most of the Queen Charlotte Islands it is generally cool, wet, and windy. The coastal areas are often rather rugged with cliffs, gullys, thick brush, and downed timber. When ocean conditions are satisfactory, travel about the coastline is aided by an inflatable rubber boat and outboard motor (20 horsepower). When travelling by boat or when backpacking, the equipment is limited by weight, bulk, and delicateness. Blinds made of wood are generally out of the question. Heavy clothes and rubberized nylon rainsuits are the usual wearing apparel. Several sizes of clear plastic bags are invaluable in protecting gear from rain, yet allowing it to be at hand when needed. With the notebook inside a plastic bag one can continue notetaking through rainy periods.

Equipment for Observing

With notebooks, pens, telescope, and binoculars, basic observing and recording can be carried out. Rather large hard-backed sewn-bound notebooks of lined paper are durable and convenient. A fast-drying water-proof ink in a Rapidograph pen (or equivalent) is satisfactory, especially when writing in humid weather and/or poor light. Wide-angle "night-viewing" binoculars are helpful for observations in poor light. A 20-40X binocular telescope allows comfortable observation of birds for hours, whereas prolonged watching with a single eyepiece telescope leads to severe eye-strain.

Blinds can be constructed of PVC (polyvinyl chloride, an extremely strong

fabric), canvas, natural or beachcombed poles and boards, and available trees and logs, all wired and staple-gunned together to provide a sturdy enclosure. (See Shea 1972 for comments on possible harmful effects of PVC vapors.) Use of hammer and nails is to be avoided, whenever possible, because the noise disturbs the birds. Blinds may be constructed at some distant point and slowly moved to a position overlooking an eyrie. Other blinds, because of the landscape, might be constructed at considerable distances from, but in view of, the incubating falcons. Care must be taken to carry out all activities smoothly and quietly.

If there is need to flush a bird from a nest during blind installation, it should be forewarned, if possible, by talking, breaking sticks, and hand clapping, and sometimes by imitating the Cacking protest of the falcons. This usually brings a bird slowly off its eggs or nestlings. When it moves toward the front of the ledge to investigate, it can be flushed without endangering the nest contents. Birds should be kept off their nests for the minimum time. Once a blind is in place, a retreat should be beaten so that the birds will be aware of one's departure and can resume their normal activities.

Camera and telescope slits, in some instances protected by projecting darkened tin cans, and one-way windows (10 x 20 cm; 4 x 8 in) provide adequate viewing. Windows can be supported in light wooden frames sewn into the fabric of the wall. The hole in the fabric can be covered, and the window tilted back into the blind for cleaning without disturbing the birds. A small shelf permits cameras and scope to be lashed (with insulated wire) into position and trained on the eyrie—even in the dark. A rather dark fabric is preferred when using one-way glass; the inside of the blind must be approximately twice as dark as the outside for the glass to function as a mirror when seen from outside.

It is important to enter blinds without being observed by the birds. If birds are disturbed, their natural incubation, feeding, and other rhythms probably will be disrupted for much of the remainder of the day. I located most of my blinds so that I could enter them through brush or trees. At some sites I was forced either to enter the blind by dark (sometimes even that did not work!) or by crawling through a low (60 cm; 2 ft high) canvas corridor supported by sticks and wire. Because of topography, cover, and visibility, most of my blinds have been placed at distances of 30 to 100 m (100 ft to 100 yds) from the eyries. Unfortunately, many pairs of falcons use several different ledges from year to year; very seldom is it possible to build blinds overlooking ledges at the end of one season in anticipation of the next.

During observations of flying birds from my exposed coastal positions, tiny clear plastic lean-to shelters have provided some protection from the elements, while allowing near-maximal visibility of the surrounding area.

Cameras are important for preserving postures and fleeting behavioral sequences. For still pictures I use 35 mm cameras with lenses in the 400 mm to 600 mm range and moderately high-speed color-slide films. Super-8, regular 8, and 16 mm movies permit frame-by-frame analysis. 150 or 200 mm lenses affix-

ed to a 16 mm camera mounted on a shoulder stock allow filming of flight actions not possible with a camera mounted on a tripod. Fairly high-speed black-and-white film (ASA 250, with filters when needed) permits rapid shutter speeds and minimal blurring of images when swift action is filmed; filming is also possible in poor light. When the camera is mounted on a tripod (or otherwise immobilized) and aimed at a specific location, an electric motor for advancing the film is useful; it can be triggered with a switch at a distance and allows longer sequences to be shot than with a spring-driven camera.

Had they been available, time-lapse motion picture cameras, videotape cameras (both with long telephoto lenses), and multichannel event recorders could have provided much useful data for this study.

Tape recorders can be used to record bird vocalizations and descriptive dictation of very rapid behavioral sequences for later transcription onto paper. A sensitive directional microphone and a parabolic reflector are useful for taping vocalizations of distant birds. Some cassette recorders are adequate, though larger portable reel-to-reel types are preferred for most sound spectrograph analyses.

Philosophy for Observing

At the start of a study a student of behavior should have a clear-cut idea of what he or she wishes to learn, as well as some understanding of the analytical procedures to be used later and the form in which the results might appear. Analysis of hard-earned and valuable raw information can be frustrating unless plans are made in advance of data collection.

One's approach is also important; it will determine not only how, but also what types of data are gathered. For example, by setting out to obtain a detailed description of Peregrine behavior, I had to *see* and *record* the full variety of activities carried out by the falcons and do this at as many sites as possible in order to detect variations between individuals and eyrie locations. Specifically, my approach involved naturalistic observations—no experimentation or manipulation. This included the following: (1) detailed objective observation, (2) accurate recording, (3) non-participant observing (the observer must not influence the animals being watched), and (4) grouping and/or classifying behavioral events (Agnew and Pyke, 1969).

At times such approach necessitated observing the whole eyrie area from a distance; this imposed strict limitations on the detail of recorded data. On the other hand, when birds are "tied" to a nest ledge, observations from blinds can be very detailed, though of a different type than those data obtained when watching a large area from a distance. If the major interest is the time budget (the use of time) of the birds, all observations might be made from a distance, over a large area; in such case, rather broad categories of behavior might be required. If a person is primarily interested in rather specific subjects (e.g., the roles of the sexes in incubation), the approach, the methods of data-gathering, and the type of data obtained will be different. Regardless of the approach, the student of animal behavior must be patient. Patience over the long term is re-

quired because certain behavior patterns might be observed only once or twice in a field season. Patience over the short term is required because a lot of time is spent waiting just for something to happen, particularly early in the courtship phase.

Observing from a Distance

To observe territorial defense, courtship, hunting, caching of food, development of flying skills in fledglings, etc., it is difficult, if not impossible, to observe from blinds. The birds simply cover too much area of the sky too rapidly. Thus I have done much observing from exposed positions, usually 150-200 m (sometimes farther) away from the base of the nest cliff, and usually off to one side. This distance appears to be a reasonable compromise between rapid and slow habituation of the birds (see below), as well as observing from too near or too far. There is a difference between individual Peregrines in their reactions at this distance, and I assume the same will prove true for other species.

Several things were important in the process of habituating falcons to my presence near their eyries.

(1) Predictability of my actions seemed to aid in the birds' acceptance of me. My travels to and from observation positions followed fairly well-defined routes, rather like the travels of deer on their trails. My clothing and speed of travel were also consistent from day to day. If observations from exposed positions began early in the courtship phase, I was apparently tolerated more readily by the birds; they seemed to accept me as a usual part of the habitat.

(2) If I had to begin observations from a new coastal position later in the season, my appearance in the area was sometimes protested. To avoid this, I very gradually worked toward the prospective observation position; I looked at flowers, pebbles, and seashells, paying no attention (outwardly) to the falcons in the area. Sometimes the birds simply would not tolerate me at a certain position; I retreated to a more distant location as soon as this became obvious. By gradually working closer over a number of days, a "trust" was built up, and the key observation position was attained without (apparently) bothering the birds.

(3) While in full view of the birds, I attempted to move slowly and deliberately; this appears to be quite important, for sometimes a single accidental sudden movement—by a human being or a deer—triggers a low intensity cacking protest from a nearby falcon.

(4) By conditioning *oneself* to be extra-sensitive to the "feelings" of the falcons, one develops what amounts to almost a sixth sense that evaluates the disturbance one is causing to the birds. By treating each protest by the bird, as being a declaration of failure of the observer to condition adequately the bird and himself, one very quickly begins to think first of the bird and its peace of mind, and only secondarily of himself and his search for information; this is as it should be. In the courtship phase and after the nestlings have flown, vocal protests are seldom directed toward human intruders. One has to rely on other indicators of fear or annoyance, such as a bird's perching posture, the lay of its

feathers, the manner of its flight, and its silent avoidance of the area where the observer is sitting.

(5) I have avoided, as far as possible, causing disturbance to the birds for purposes such as banding. I feel that that interferes with habituating them to accept me near their nests. Such disturbances may indirectly limit not only the distance to which I can approach the birds, but also type of information I might obtain from the exposed observation positions.

(6) One serious problem is that of desertion of a nest. By visiting the top of a cliff on which a pair of birds appeared about to nest, I have caused the birds to shift as much as half a mile to another cliff to lay their eggs. As pointed out by Herbert and Herbert (1965:81), if the birds are disturbed part way through laying of the clutch, they sometimes will desert the ledge and finish laying the clutch at another ledge.

(7) There is considerable variation in the attitudes of the birds towards the observer; this must be taken into consideration. The observer must also be careful to habituate both birds of a pair to his presence.

The success of the habituation process should be evaluated continually by using the birds' reactions. When birds will voluntarily and regularly carry out certain activities within 100-200 m of the observer (e.g., Food-transferring, Copulating, Ledge Displaying, feeding nestlings, perching, and dozing), then they are probably adequately conditioned. By also observing them from much greater distances, one can get an impression of whether or not the data obtained from 100-200 m are in any way abnormal.

When watching, one soon realizes that there is some pattern to the life of birds. Usually there is a series of favored perches, perhaps used in relation to the direction of the sun or wind. There is a roughly predictable series of events during the day, particularly near dawn and dusk, perhaps with more variability to the pattern during the remainder of the day. Certain actions will be recognized as forerunners of other actions. These patterns can be used to advantage; they warn an observer to be ready to record or to photograph certain other actions. Other activities will tell the observer that he can take a moment to relax.

The regularity of certain actions allows one to locate the birds more readily at the beginning of an observation period or after a bird suddenly disappears. Aside from learning the usual actions of the birds being observed, it is also helpful to scan the area at intervals to detect other raptors, prey, or changes in weather. It is also helpful to practice estimating distances over known terrain, so that it becomes second nature to recognize how far away and how high a bird is when it does something of interest.

Observing from Blinds

While blinds allow intensive observations at nests, they also can be versatile enough to permit following of adults when they come and go. It may be pos-

sible to locate perches in this way, thereby allowing records of not only the activities at the nest, but other behavior as well. For this reason, several windows should be provided in each blind.

At one site I used a portable blind consisting of a single piece of light-weight green canvas measuring about 2 x 3 m (6 x 9 ft), provided with a single 15 cm slit in the middle, one-third of the way along its length. The pair of falcons was courting at a new ledge on the side of a narrow gorge. Without a blind of some sort I would have been unable to observe courtship activities at or near the ledge; yet, building a blind only 30 m away would almost certainly have caused them to desert the ledge. The ledge was not visible from any greater distance. The portable blind was used on several days in the following manner: I crawled (unseen) to near the edge of the gorge on the side opposite the ledge; by covering myself with the canvas and then very slowly rising to a kneeling position, I peered through the slit in the canvas, down and across the gorge onto the ledge; and I trained a camera (on a tripod) on the ledge from within the canvas. The birds hardly glanced at the apparition on the opposite rim of the gorge. I can conclude only that they must have considered it to be some kind of animated bush. In any event, the technique permitted detailed observations of Ledge Displays which, until that point, had been only poorly observed from great distances. The birds produced a clutch at that ledge, and later I was able to construct a blind and move it into position.

I suspect that there is much to be learned in the way of camouflage and disguises that will permit close approach to certain raptors. When I receive a protest at 100 m from a Prairie Falcon eyrie, yet a group of cattle wander about 5 m below the eyrie and apparently cause no upset to the falcons, I seriously consider the possibility of using the Indian technique of draping oneself with a buffalo (or cow) hide and attempting to move closer.

Recording Information

The method of recording information will depend to a considerable degree on the purposes of the study, the manner in which the data are to be used, and personal preferences. Both from blinds and from exposed observation positions, it is immensely helpful to have a number of photographs taken of the view, the eyrie, landmarks, and surrounding features, to refresh one's memory and to aid in the analysis of the written information later.

Because many behavior patterns occurred so rapidly and so seldom, I attempted to record everything that I considered to be of any possible significance. I recorded events as they occurred, by hand, almost in a diary form. I abbreviated the names of behavior patterns (once they were adequately described), the species of birds, landmarks in the area, etc., for the sake of brevity. When some activities occurred too rapidly to be written down, they were dictated into a tape recorder and transcribed later, usually within a few days.

From such copious field notes it *is* possible (but not necessarily easy) to extract a great deal of useful information, both qualitative and quantitative. By using this method I have discovered in the notes some stereotyped behavior pat-

terns that I was not aware of in the field simply because they occurred so very seldom—and so swiftly. When read several hours or several days apart in the notes (instead of several weeks apart in the field), certain patterns became specific displays. Further, the diary method, if adequate data are recorded, allows one to answer a number of entirely new questions posed years after the data are gathered.

Prepared data sheets for recording behavior patterns and other aspects of the birds' lives are useful at a later stage once one knows what the various units to be recorded are and has decided which to record.

In the notes I attempted to describe exactly when and where the birds went, what they did, how long it took, and just how they did it. By doing so I was later able to plot on photographs and maps the routes used and the areas covered. Similarly, it was possible to plot their perches, food cache sites, and ledges. A perched bird can be described in the notes as being exposed to sun, wind, or rain, or in view of its mate. The direction the bird's body faces can be easily noted, as can the direction in which the bird is looking. When watching a bird on a ledge, I mentally superimposed the image of a clock face down upon the bird (with 6 o'clock towards me), and was able to read off the position of the bird on the scrape—for example, "incubating at low position, facing 10:30, looking often towards 9:00." This sort of data, coupled with a sketch or photograph taken from the observation position and knowledge of the direction that the ledge or cliff faces, can provide useful information on the preferred incubation positions relative to the exposure of the ledge, cliff, and other factors.

I regularly inserted into the notes brief synopses of the weather—wind speed and direction, cloud cover fraction, sunshine, precipitation, and condition of the ocean. Changes were noted as they occurred. These synopses allowed me to relate behavior to local weather. Weather influences the lives of the birds considerably.

The time of day was frequently stated at some obvious place in the notes (e.g. in the left margin), especially at the start, during, and at the end of behavior sequences. Often even the seconds were recorded.

The description of vocalizations is always difficult. Initially, I attempt to describe at some length, in writing, a new vocalization or a variant of a recognized one. This consists of constructing a word that attempts to duplicate the sounds. Additional words describe variations of pitch, syllabication, accent, and loudness. Of equal importance is a detailed description of the circumstances in which the call was given. Without all of these aspects of vocalizations we may never understand what the various calls actually mean. For example, Richard Fyfe and I are experiencing difficulty in sorting out and recognizing the number of variants in the "Eechip-complex" of calls (as we term them) given by the Peregrine, particularly since these calls are given in widely varied circumstances. We may have to resort to sound spectrograph analysis in order to *see* the differences.

Tape recordings of vocalizations, augmented by written or dictated notes about the sex and age of the bird and the circumstances in which the call was

given are very valuable. Such recordings and descriptions of the same call taken at intervals as the season progresses may show gradual changes through the season—changes not recognizable in the field. One obvious change is in the begging calls of the nestlings.

The use of a tape recorder as a convenient means of note-taking has definite drawbacks. Once something is written, one can quickly check it for accuracy and correct it, if necessary; with tape recorded notes this is difficult. Furthermore, it is easy to omit important items when talking into the recorder, whereas omissions can be detected and filled in if notes are written. The worse problem with tape-recorded notes is transcribing them. One hour of tape equals two to three hours of transcribing. With a secretary to do the initial transcription, much time and energy might be saved, though almost certainly the tape will have to be compared with the written account afterwards to fill in omitted material (if it still can be remembered). If a sequence is taped, the time and date should be placed onto the tape also; a large space must be left in the notes for the transcription, with a brief note indicating what occurred and the fact that it is on tape. This facilitates transcribing the tape into the proper section of the overall notes.

In short, for important sequences where the observer must keep very close watch on rapidly-occurring activities, tape-recorded notes are invaluable; for routine note-taking, pen and paper suffice.

The time and subject of still and motion pictures should also be written down in some convenient shorthand so that later they may be labelled accurately. And photographs should be taken not only to illustrate unusual and interesting aspects of the birds' lives, but also to depict the usual and mundane aspects, in order to present a reasonably well-rounded description. I find, for example, that I have no photographs of an adult falcon muting or rousing!

Partly because of weather conditions and partly because of the ease with which birds are lost to view when flying at some distance, I have avoided tracing flight paths directly onto maps, aerial photos, or plastic overlays while in the field. I simply describe the bird's path in writing and draw it onto maps or photos later.

Sketches of many things can also add immensely to the usefulness of one's notes: positions of eggs, postures or flight patterns of the birds, the outline of a ledge, perch or cliff.

The timing of observation periods bears some planning. By making observations at roughly the same time of the day and for the same duration of time, the data will more readily provide comparisons between days with differing weather or at different stages in the season. While regularity of observing has definite advantages, watches scattered through the day will provide suggestions as to daily cycles of activities. For certain aspects of behavior, observation periods of ½, 3, 5 hours, etc., might suffice. For other types of activities, e.g. the number of feedings per day or the number of incubation shifts per day, dawn to dusk vigils are necessary; however, with daylengths of 16 hours or more, it is almost

impossible for one person to make meaningful observations of this sort for two days in a row.

Thus I have found it useful to designate certain one-hour periods as "intensive observation periods" in which all major and minor activities are recorded with no distractions (e.g. for photography). Such observations are most productive when interspersed within regular observation periods when only more major activities are recorded.

Analysis

The challenges of analysis of data collected as described above come in asking the right questions and then seeking the answers in the amassed data. I find this more exciting and useful (though more time consuming, perhaps) than asking all questions before I go into the field and seeking only data to support or refute preconceived ideas. The relative merit of these two research philosophies is a moot issue. The first step in analysis of the types of data I collected is devising a means of cataloguing and categorizing the facts. In the field I write only on the right-hand pages of my notebooks. I leave the left-hand pages for short remarks on photographs or tape recordings, for sketches, and, most important, for a form of succinct indexing (in pencil) of what is on the right-hand pages. Depending on one's preferences and how the data are to be handled, a wide variety of further means of indexing, summarizing, and extracting can be worked out.

Innumerable forms of data presentation are possible. Drawings and photographs are useful ways of supplementing qualitative description of behavior patterns. Data plotted onto maps or presented in graphs or tables add to quantitative descriptions.

Figure 1 illustrates how a photograph or a drawing (in this case, traced from four overlapping photographs) might be used to show the positions of perches used near the eyrie. Similar illustrations might show how perch use varies during the courtship, incubation, nestling, and fledgling phases. Small histograms or pie-charts might show the preferences for particular perches. (All figures are reproduced from Nelson 1970.)

From a description in the field notes, Figure 2 plots a flight path onto a drawing of the cliff-front. With a series of plastic overlays, many such flights can be superimposed onto one drawing, photograph, or map, to illustrate what areas are used for various purposes.

Each drawing in Figure 3 was traced from projected images on 35 mm slides. Despite the fact that the images of the birds on the slides were very small (due to an inadequate telephoto lens), useful pictorial material *was* obtained to show the changes in feeding and begging behavior at intervals through the whole nestling phase. 35 mm photographs are also useful in stopping action in a very rapid sequence which might be only a blur to the human eye. Figure 4 is a cropped photograph of a fleeting event that usually leaves the mind and eye puzzling as to what really happened. In raptors, there are many such activities which lend themselves to photographic analysis.

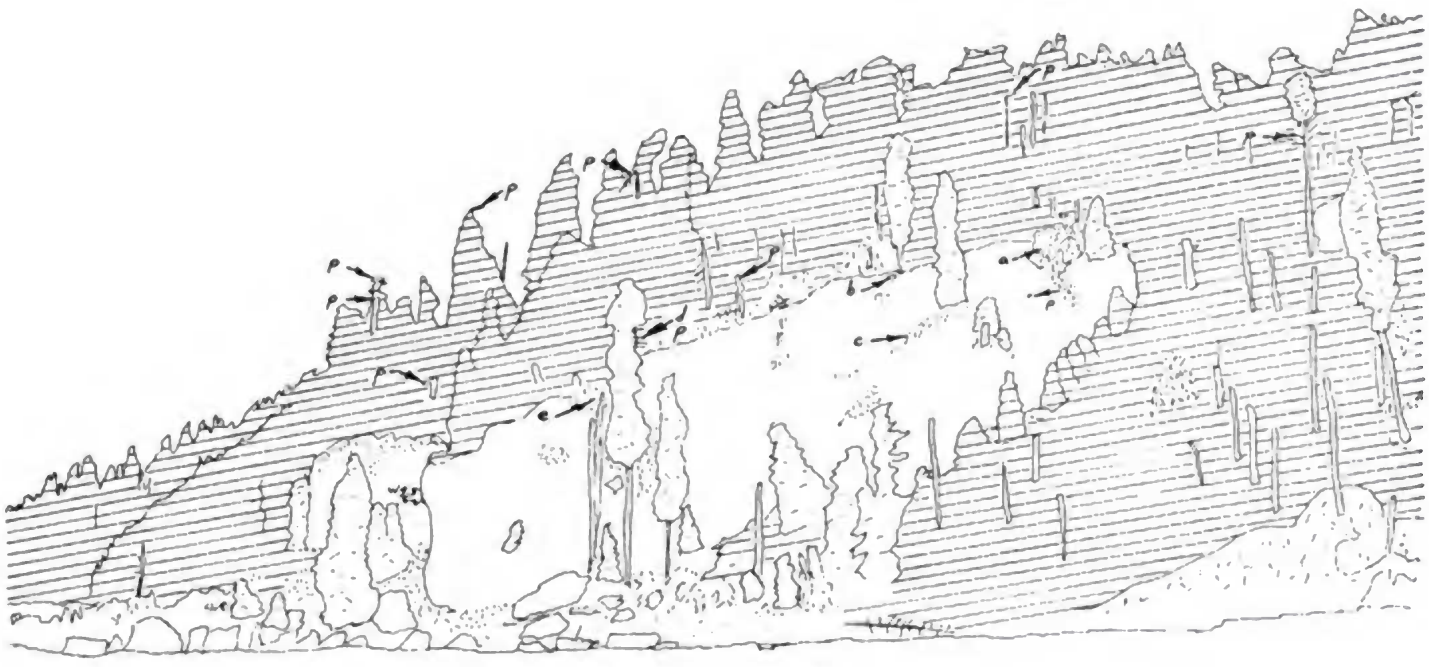

Figure 1. Drawing of nest cliff at Area B indicating important ledges and trees used by the falcons in the 1969 season. (a) The 1968 eyrie location. (b) The "new ledge." (c) The "grass strip" ledge at which the falcons raised their young in 1969. (d) Favored site for Food-transfers on the conspicuous branches of the tall tree in front of the cliff. (e) Usual food cache area in grassy area on cliff (partly hidden behind tree in this view). (p) Favored perches. (wg) Location of the West Gorge.

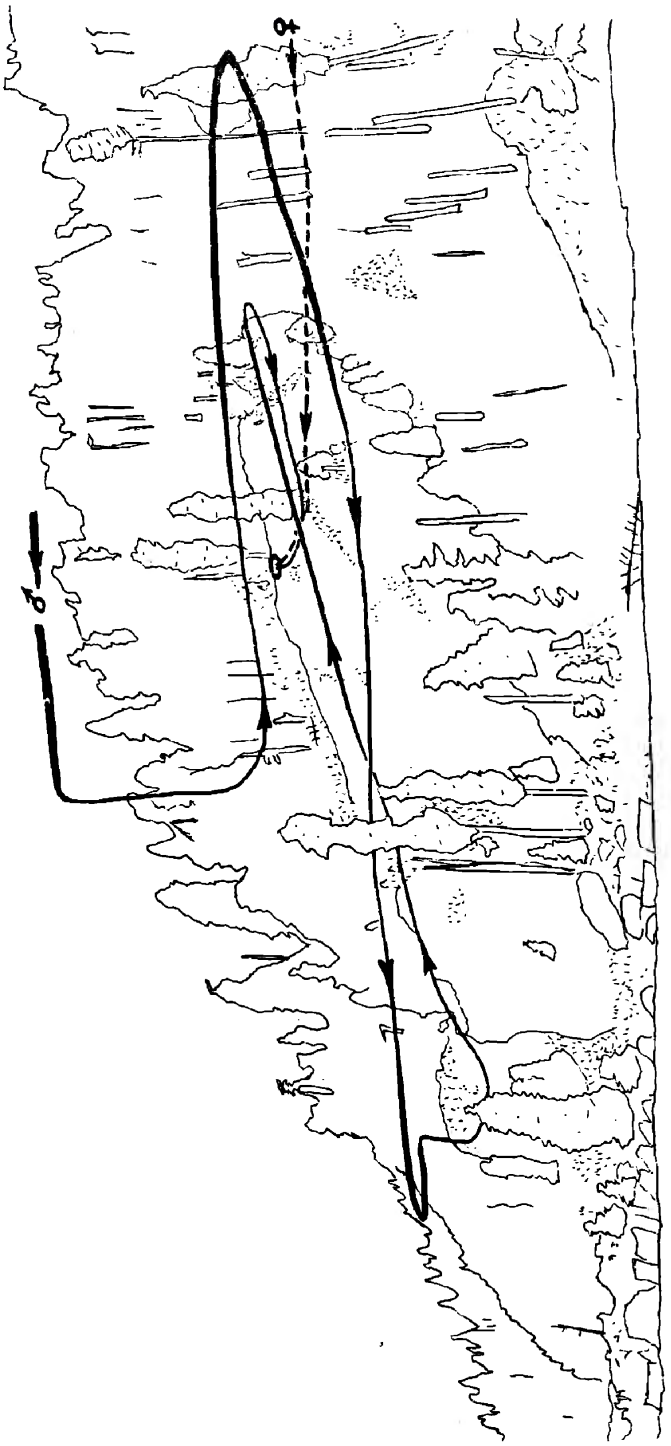

Figure 2. Path taken by adult male Peregrine Falcon in the Power-diving, Cliff-racing, and Male-ledge Displays; 13:29 hrs, 12 March 1969. Thinner line indicates more rapid flight. The two vertical portions indicate Power-diving; the thin horizontal portions in front of the cliff indicate Cliff-racing. Male-ledge Displays occurred as soon as he landed. 15 seconds later the female (broken line) sailed in from the east (right) and joined him at the preferred ledge.


a
b
c
d
e
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g
h
i
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k
l
m

Figure 3. Development of feeding and begging behaviour in nestling Peregrine Falcons.
(a) Age 1 day. (b) Age 8 days. (c) Age 10 days. (d) Age 14 days. (e) Age 22 days.
(f) Age 22 days. (g) Age 23 days. (h) Age 29 days. (i) Age 29 days.
(j) Age 31 days. (k) Age 31 days. (l) Age 36 days. (m) Age 50 days; 7th day of flying.

The nestlings orient nearly vertically until about two and one-half weeks of age, but even then they reach towards the adult's beak rather than towards the food held in the adult's feet.

Until they are two weeks old, the nestlings remain mostly in the vicinity of the scrape.

At 22 days of age (e), the nestlings, though quite capable of doing so, do not always move to the adult as soon as it arrives on the ledge with food. The adult usually takes the food to the nearest nestling and proceeds to feed it, but the other nestlings may call from a distance. Usually, after some time, they will move to the adult to receive some food, but their feeding is usually seen to be not highly motivated in such instances (e and f).

By 23 days of age (g), they call strongly at the adult if it arrives without food or leaves before all are satiated.

By 29 days (h) they beg vigorously at an adult whether it carries food or not. From this time on, more and more frequently they seize the food from the parent (j), but they will sometimes still accept the food as the parent presents it to them individually (i).

In (j) one nestling which has ripped the food from the adult may be seen mantling over the food and facing away from the adult and other nestlings. In such situations the adult usually is harassed to such an extent by the unfed nestlings that it leaves the ledge.

The Horizontal Posture (h) is usual by 36 days of age (1). If an adult is flying over, however, the young falcons face toward the adult and do not show the Horizontal Posture. In (m) one of the fledglings can be seen to be turning its head on its side while looking upwards at an adult flying over the fledglings' stump-top resting location.

(Traced from 35 mm colour transparencies taken at Area A, 1968.)

Figure 4. Two fledgling males "playing tag." The "attacker" has pulled out of its swoop and is lowering its feet as it passes over its brother. The "attacked" fledgling has rolled completely over and is presenting its feet towards the "attacker." From a 35 mm color transparency.

Frame-by-frame analysis of motion picture sequences can be presented by means of photographs or tracings made from the film. Figure 5 is an example: a Bald Eagle's complete roll-over in full flight is seen in its various stages–the roll-over occurring in about one-half second, the over-all sequence lasting almost one and one-half seconds. With a projector that will stop on individual frames, each image can be traced from the screen at almost any size imaginable. By tracing onto acetate plastic, it is possible to arrange a number of tracings on a page, and then to photocopy the whole set. One can also produce a single final tracing, on paper, with the assistance of a light-table. The result is often a pleasing and instructive illustration, demonstrating something that the eye normally is incapable of registering.

In addition to cataloguing one's notes, a detailed cataloguing system for photographs, movie sequences, and tape recordings is highly desirable. This permits these data to be extracted quickly for analysis. At a minimum, each picture or sequence should be labelled with a date, time, location, and summary of subject matter.

Numerical data concerning how often or how many events occurred can be treated strictly as numbers in tables, with appropriate statistical tests when required. Such data may also be presented in graphical form. Figure 6 demonstrates a means of showing the observed occurrence of selected behavior patterns through time, in this instance through the season rather than the day.

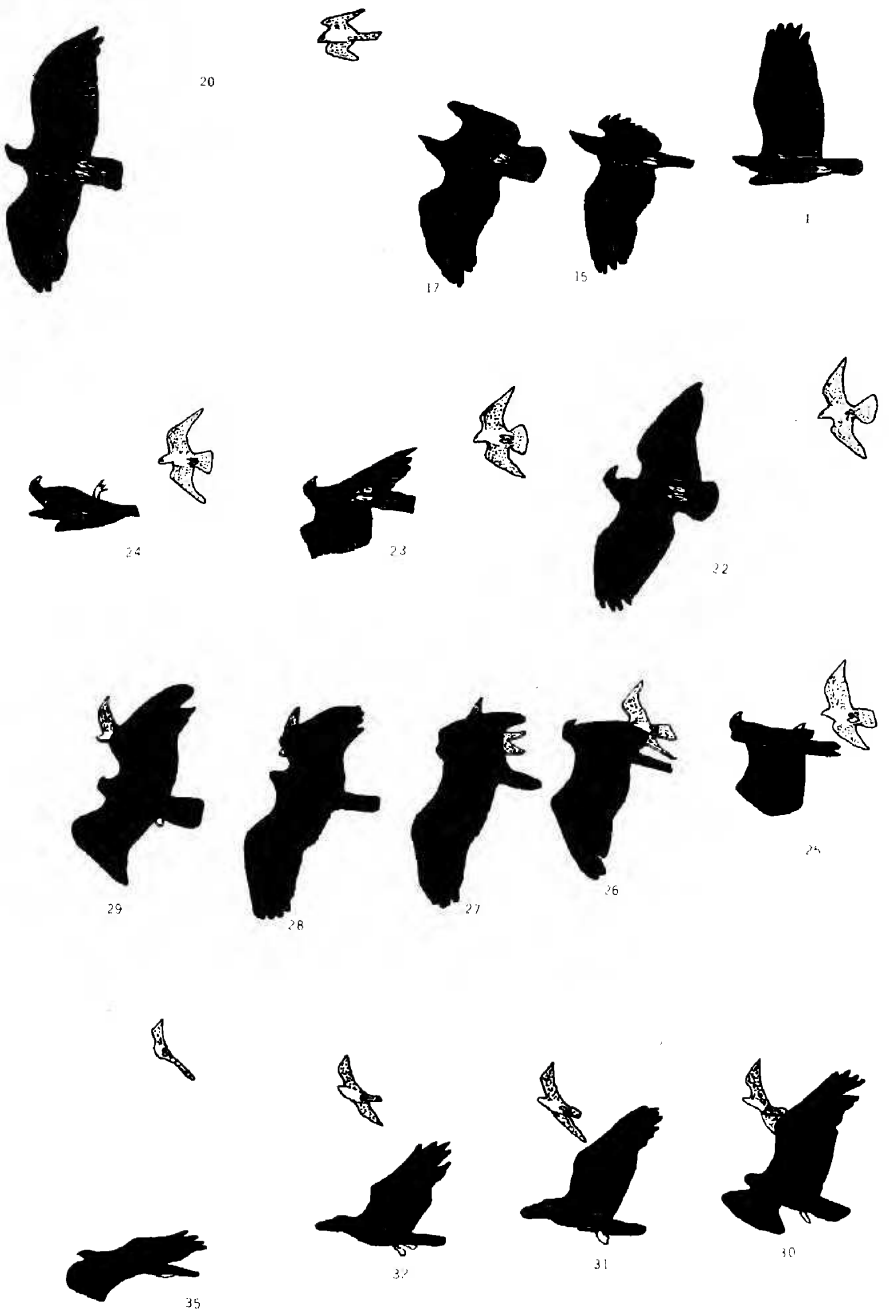
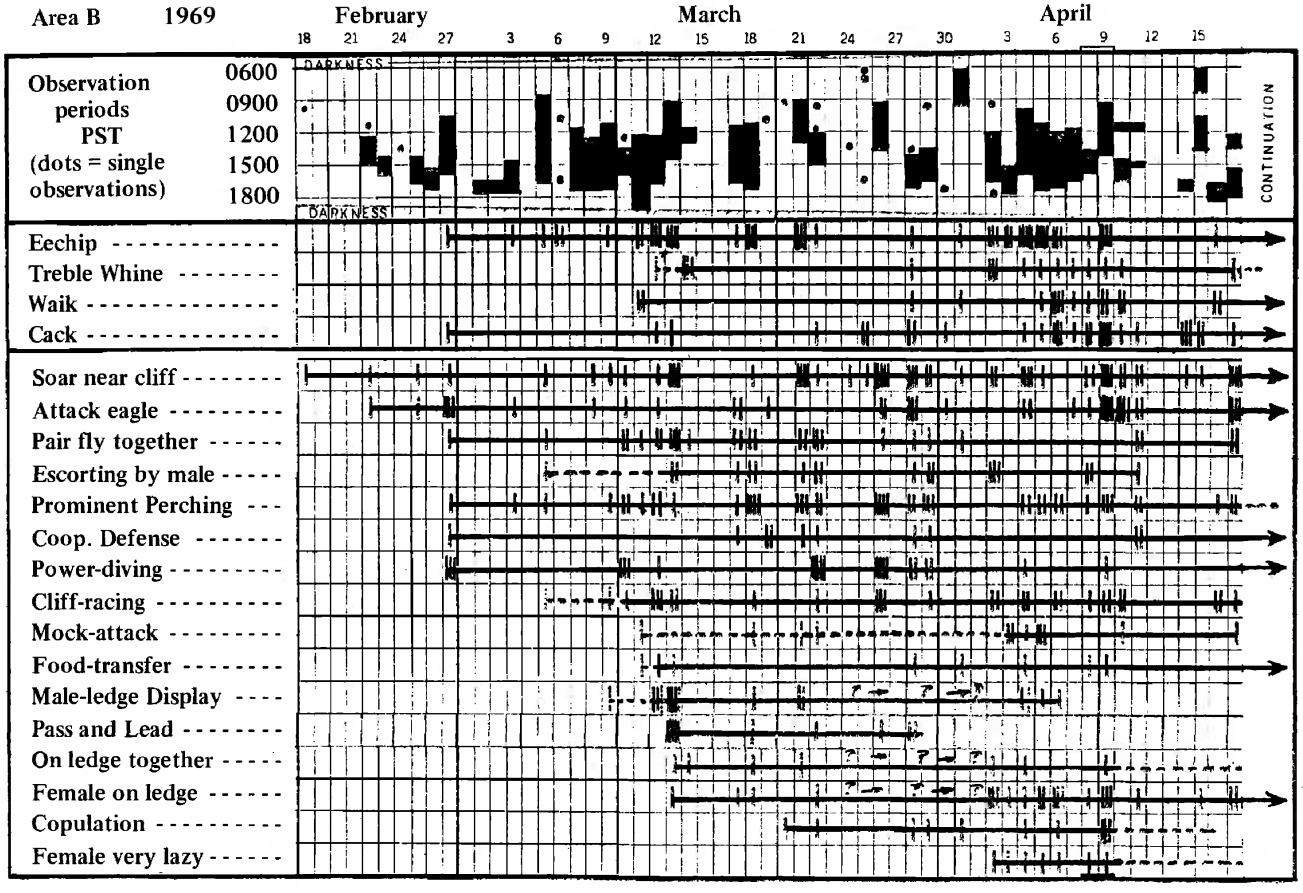


Figure 5. An example of the use of frame-by-frame analysis. A falcon attack upon an immature Bald Eagle. Read right-to-left, top-to-bottom. Traced from 16 mm motion picture film exposed at 24 frames per second. Numbers indicate frames in the sequence.

Figure 6. Important preincubation behaviour patterns. Solid lines = observed occurrences; dotted lines = uncertain observations. ? = pair relocated; ledge actions not observable. First egg laid April 8-9.



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